March 2004

Friends of the Earth

Briefing

The Voluntary Initiative and Water Pollution

Executive Summary

The Voluntary Initiative's measures to reduce pesticide pollution in water are of limited value if heavy rainfall occurs soon after the herbicide isoproturon (IPU) is used on cereal crops.

The Voluntary Initiative (VI) programme is based upon a research project in the Cherwell catchment in Oxfordshire.

In the Cherwell study 1998/99 and 1999/2000 the amount of IPU in the river increased by 981 per cent between the two years because of the timing and intensity of rainfall in the second year.

The Cherwell study showed that filling and cleansing operations and spray drift can increase the amount of IPU in rivers. Pollution from filling and cleansing operations can be reduced if they are carried out on porous surfaces rather than paved areas which are drained to water courses.

The Cherwell study showed that spraying headlands last can minimise the amount of IPU transported off fields on vehicle tyres.

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There is no evidence that actions in the VI Catchment partnerships projects have themselves reduced pollution. In the Blythe and Leam catchments IPU levels fell in 2002/03 as a result of bad weather which prevented spraying of IPU.

No measures apart from an outright ban are likely to reduce IPU levels below the 0.1 μg/l threshold set in the EU Drinking Water Directive.

Introduction

The Voluntary Initiative (VI) has placed a good deal of emphasis on changing farmer behaviour and practices as a way to reduce the pollution of surface water. The UK water industry spends around £100 million per annum treating water to remove pesticide residues so that drinking water meets the standards set in the EU Drinking Water Directive (maximum concentration of 0.1 μg/l for a single pesticide, 0.5 μg/l for total pesticides). The most frequently detected pesticides in untreated water destined for the public supply are the herbicides isoproturon (IPU), atrazine, simazine, mecoprop, MCPA and 2,4D. The VI's task will be made easier by the EU's failure to approve atrazine and simazine after 2005, and the VI targets should be adjusted to reflect these decisions. The VI has set targets for pesticides in untreated water. Their plan for delivering these targets draws heavily on the findings of an industry sponsored study on a single catchment in Oxfordshire.

This briefing examines the findings of the study in detail and suggests that changing farmer behaviour alone will not prevent pesticide pollution of surface waters and the need for water treatment prior to it entering the public supply.

The Voluntary Initiative Targets

The VI has set a national target of reducing the frequency of detection of individual and total pesticides above EU drinking water maximum concentrations by 30 per cent by 2006, with interim targets for 2003, 2004 and 2005. The VI has not set a target for pesticide contamination of all surface waters to be below 0.1μg/l, which would allow water companies to reduce or abandon treatment of raw water.

The Voluntary Initiative Approach

To achieve the targets they have set themselves, in order to head off a potential tax on pesticides, the VI has instigated a number of initiatives.

- They aim to improve farmer behaviour by improving the training of spray operators
- They ran 30 Operator Road Shows in 2000-02 around the country.
- They have distributed literature on the need for greater care in sprayer filling and cleansing operations and in pesticide application.
- They have set up six "Catchment Collaboration" projects which are intensive programmes aimed at producing a "downward trend". The six catchments are the River Ugie (Aberdeenshire), Inbirchworth (South Yorkshire), Boston Park (near Doncaster), River Blythe (Staffs), River Leam (Warks) and River Cherwell. All catchments provide water for public supply and have a history of herbicide pollution.

The rationale for these projects largely comes from a single study of the Cherwell catchment[1] in Oxfordshire over two cropping seasons from 1998-2000.

In a progress report presented to the VI steering group (Paper No 02/0053 28th May 2002), the project outcome for the catchment projects was for a 50 per cent reduction in water contamination. In draft literature the VI made the claim that “the Cherwell study in Oxfordshire found that 40 to 60 per cent of surface water contamination can come from farmyard operations”[2]. The Crop Protection Association (members of the VI) CD-ROM “Avoiding Water Pollution (Tutors Notes)” published in November 2001 claimed that the Cherwell study “showed that nearly 50 per cent of the surface water pollution originated from farmyard sources”.

The VI leaflet setting out the eight points of the code of practice includes the statement:

“Pick your filling site with care – about 40 per cent of contamination of water by pesticides is caused by run off from farmyards”

The Cherwell Catchment Study

The Cherwell project only looked at one herbicide: isoproturon (IPU). It was carried out by ADAS Consulting on behalf of Aventis CropScience. It looked at the movement of IPU through a small arable catchment at the top end of the River Cherwell basin. IPU is a commonly used selective weedkiller used on winter cereal crops. It is highly soluble and mobile in the environment.

Water quality monitoring in the River Thames catchment at the Walton public supply abstraction point had previously indicated that IPU levels above the EU permitted maximum concentration were frequent. This also showed that IPU levels in the raw water entering the treatment works began to peak for IPU before the land drains began to flow following autumn and winter rainfall. This led to the supposition that point sources could make a “more significant” contribution compared with diffuse pollution (ie run off from cultivated land after application) than previously thought.

The objectives of the project were to:

- Characterize the magnitude and frequency of surface contamination by isoproturon within a discrete catchment area.
- Identify the relative contributions of isoproturon from point and diffuse sources
- Provide practical, efficacious and economical solutions to minimising losses from point sources.

At this point it is worth pointing out that the pilot study did not look at pollution of groundwater with IPU. Problems with filling and cleansing operations on farmyards are not new, and good practice was written into the Code for Good Agricultural Practice. Friends of the Earth have direct experience of river pollution arising from herbicide rinsate being tipped onto paved surfaces, running down drains and into surface waters and causing fish kills in the Vale of Evesham in the 1980s.

The Cherwell study took place on a 100 ha agricultural catchment in the period following IPU applications in November 1998 and November/December 1999. In the first season “investigations focused on farmyard activities which might contribute to point source contamination of IPU”. In the second growing season “tank filling and washing practices were modified to minimise point source losses”. In each year 40 per cent of the land ("drained clay") was under winter cereals and therefore treated with IPU. Surface water monitoring points were set up at strategic points in the catchment each year to gauge the relative importance of point and diffuse sources to the measured amounts of IPU in the River Cherwell. Flow measurements were also taken so that the weight of IPU present at any one time and at two points could be calculated: concentration in μg per litre multiplied by flow in litres = total weight of IPU in μg. By using this approach the percentage contribution of the load of IPU in the river from known point sources could be calculated.

The movement of IPU in the environment results from either rainfall washing it from hard surfaces into drainage systems, from soil or porous surfaces into field drains and ditches, or washing down of paved areas. Spray drift and over spraying of ditches are additional sources of diffuse pollution.

The weather in the two years of the study was significantly different. In year one, 22 days elapsed between IPU application and significant rainfall. In year two, only four days elapsed after IPU application before 5.6mm of rainfall occurred. In both years the host farmer employed the same spray contractor to apply IPU. The contractor was aware of the study and co-operated by using Good Agricultural Practice and changing the location of filling, mixing and cleansing operations in year two from the concreted farmyard to a porous site. In both years the amount of IPU sprayed was roughly the same (100kg) at a rate of 2.5kg/ha over 40 hectares.

The Cherwell Catchment Study Results

In Year one of the study, sprayer filling and cleansing operations took place on a concrete farmyard which drained into the upper reaches of the River Cherwell. The researchers took detailed measurements of the amounts of IPU that were deposited on the paved surface and were potentially available to be washed into the river system. The following sources were identified:

ADAS estimates of IPU sources on farmyard

From glugging and splashing during filling	0.4mg
Leakage from empty containers	350mg
Leaking pipe	1200mg
One litre of rinsate	470mg
Potential loss from sprayer and tractor washing	671mg
Mud on wheels of tractor: 8-10mg/kg (average 9mg/kg) Amount of soil on yard after spraying: 40kg Potential loss from tractor wheels (9 x 40)	360mg
Total potential loss from yard operations	**3051.4mg (3.0514g)**

The total weight of IPU spilt on the yard during various operations was 0.003 per cent of the total actually sprayed on the fields.

IPU concentrations were regularly measured above and below the yard where filling and cleansing operations occurred as well from field drains and in the river. IPU was not detected in the catchment before spraying operations commenced. Flow was monitored as water left the catchment and the yard drainage. Despite the lack of rain immediately after spraying ended until 9th December, IPU was found in the outlet of the catchments in concentrations as high as 44.3 µg/l on December 7th 1998.

This led to the conclusion that “the likelihood of general diffuse losses of IPU from the drainage network is extremely remote”.

There were several changes in practice between year one and year two of the Cherwell project. Firstly filling and cleansing operations were deliberately removed from the paved yard to an area of hardcore to reduce the potential for direct run off to surface waters. However this did not completely prevent surface run-off via “shallow trenches”. The report does not provide any information on the fate of the water in the “shallow trenches”. Other changes included:

- Spray equipment not coated with mineral oil.
- The location of the cereal fields being sprayed with IPU
- Changes in monitoring points to reflect different cropping pattern.
- Shorter time interval between spraying and the first major rainfall, and the amount of rainfall.
- Pesticide packaging was incinerated and not rinsed out and disposed of as solid waste.
- Spray operation took place on two different days (18th November and 11th December).
- A sprayer pipe blow out occurred increasing amounts of mud containing IPU on tractor wheels.

The amount of IPU on the machinery post-spraying (8245mg) was 1247 per cent greater in year two than year one, and the amount available for potential loss was 1229 per cent greater in year two.

IPU loads (g) in the Cherwell Catchment 1998/99 and 1999/2000

		Sampling point		
		Flume Upper catchment	**Farmyard**	**Culvert catchment exit**
Year 1: 1998/99	Load (g)	No data	5.304 (actual recorded total)	13.964
			3.0514 (ADAS estimated potential available)	
	Percentage of catchment total	No data	38% (actual recorded total)	100%
			22% (ADAS estimated potential available)	
Year 2: 1999/2000	**Year 2: 1999/2000** Load (g)	209	0.248	137
	Percentage of catchment total	153%	0.18%	100%
Percentage change year 1 and year 2		No data	Minus 95% *(92% based on ADAS data)*	Plus 981%

In year 1, two figures for loading at the farmyard are present – one based on the recorded flow and concentrations and the other based on ADAS's estimate of the total available

It is clear from year 1 of the study that the contribution of yard runoff to the loading of IPU in the Cherwell was significant in November and December due to the lack of rain but the total amount of IPU in the river was relatively small. For the whole of the monitoring period the yard contribution was 38 per cent but was as high as 52 per cent in November. If the consultants' measurements of the potential amount available to run-off the yard are used (3.0514g) instead of the calculated load from the farmyard, the percentage contribution of the yard falls to 22 per cent. This again suggests monitoring was not sensitive enough to accurately measure IPU loadings. There is further reason to doubt the reliability of the figures for the contribution from yard run-off: in December of year one both flow and load for the farmyard were larger than those recorded in the Cherwell culvert further downstream, implying that water flowed uphill. There are several other examples of this occurring in both years of the trial. Further evidence of the lack of sensitivity in the model comes from year two IPU loadings which were highest at the flume sampling point – the highest point in the catchment where load was calculated when the highest figure should have been at the lowest point.

The amount of IPU on the machinery post-spraying (8245mg) was 1247 per cent more in year two than year one and the amount available for potential loss was 1229 per cent greater in year two. Wind speeds were higher in year two and this may well have contributed to the higher amounts of IPU found on the spray equipment post-use.

Results from year two mirrored year one, in that no IPU was detected in the catchment prior to spray operations.

Analysis

The loadings increased at the exit to the catchment by 981 per cent between 1998/99 and 1999/2000, despite successful attempts to reduce the amounts of IPU entering the Cherwell from the farmyard area by shifting operations from the paved area to the hardcore area: the amount of IPU running off the farmyard decreased by 95 per cent.

The difference in the results between year one and two shows how significant rainfall is in moving IPU down the catchment. If the year one filling and cleaning practices had occurred in year two, the contribution of yard runoff to total IPU at the lowest point of the catchment would have been 3.8 per cent (2.2 per cent if ADAS's potential load figure is used) compared to 22 or 38 per cent for year one.

Thus the IPU load figures for year one indicate that between 62 per cent and 78 per cent of IPU leaving the catchment came from sources other than the farmyard.

The ADAS report gives several indication of what these might be:

"It is likely that the first two peaks in IPU concentrations detected at the culvert on the day of application at around 11.00 and 14.00 were caused by spray drift"

And

"The presence of IPU in water taken from SS18, the River Cherwell channel, on the afternoon following spraying supports the ideas of the direct input of diffuse sources such as spray drift”.

And

“The lack of detection in a sample from DO17 at this time suggests that the soil moisture content was too low to allow any hydrological connectivity between treated soils and land drains. The detection of IPU in a sample from DO17 following the first major rainfall event after application (26 November) suggests that connectivity had been established by that time.”

The suggestion that spray drift might have contributed to the amount of IPU in the Cherwell in 1998/99 is hardly surprising when details of the spraying operation are examined.

“IPU was sprayed right up to the bank top, so the distance between the edge of the spraying zone and the water in the ditch (if present) was about 0.5-1.0m”. There was a wind speed of 6.5km/hr on the spray day.

The Cherwell report suggests that spray drift may have added to the IPU load in year two as well, due to “overspray into tributary ditches adjacent to the treated fields”. However, the frequency of the monitoring does not allow this to be confirmed. What it does suggest is that Good Agricultural Practice as practiced on this trial farm is inadequate to protect water resources from IPU pollution.

The ADAS report for Aventis CropScience concludes “the results of the first year of investigations at the Cherwell catchment suggest that the contribution of IPU to surface waters from the farmyard as a point source was more significant, both in magnitude and duration, than previously recognised”. This is a convenient conclusion for Aventis CropScience and the VI because it enables them to place more emphasis on application, filling and cleansing operations as a means to reduce peak concentrations in river water destined for public supply, rather than reduce the actual use of IPU in October, November and December.

In year two, when rainfall occurred soon after the first application of IPU and was generally more intense, IPU loadings indicate that point sources were relatively insignificant compared to IPU washing from soils and down field drains and ditches (2.2-3.8 per cent). No analysis of the potential for spray drift to contribute was presented although year one data for the period after application suggests that it could be a significant contribution to the total, especially in dry years.

Data presented on IPU in soil on the wheels of spray equipment indicates that the order in which cereal fields are sprayed can influence the amount available to run off paved surfaces. When headlands were sprayed first, IPU concentrations in mud on the front tyres were more than 3.5 times higher then when headlands were sprayed second. For rear wheels IPU concentrations increased nearly 3.2 times. It is thus clear that running over previously sprayed areas can result in IPU being moved around the catchment on the spray equipment. Although some of this mud will have been deposited on paved surfaces and thus would be liable to be quickly washed down drains, it is equally likely to have been lost on other farm tracks (paved or hardcore) where its fate would depend on the porosity of the surfaces, amount of surface water (puddles which could wash soil off wheels) and rainfall. The ADAS report makes no attempt to assess these alternative routes for IPU on tractor wheels to enter water courses or groundwater. Some may also have been transferred off catchment if wheel cleaning operations were less than 100 per cent effective.

The suggested explanation for the ten-fold increase in IPU loading in the Cherwell in 1999/2000 was “that diffuse loss through field drains in the catchment provided a significant source of IPU contamination during year two”. The ADAS report suggests that the “moist (not saturated) soil conditions at the time suggest that the hydrological link was made through field drains and tributary systems, rather than by runoff from the IPU treated field”.

Conclusions and VI Voluntary Measures

The Cherwell study demonstrates many of the problems in obtaining an understanding of how a single pesticide moves in the water environment. It does provide useful data but monitoring frequencies mean that the model is less sensitive than would be required to get a full picture of how IPU behaves. It may provide some help in understanding how other herbicides might find their way into water-courses but their properties (eg solubility) may give different results.

The massive increase between year one and year two loading in the River Cherwell are largely due to differences in the timing and intensity of rain fall. The conclusion from year one that yard operations can make a significant contribution to IPU loading in rivers only applies to years with low rainfall in the period after spraying, and on what could be considered as bad practice in filling and cleansing spray equipment. The ADAS report suggests that a nine day dry period after application would be needed to have the effect of reducing run-off of IPU from fields. Over-spraying and spray drift can add to IPU loadings, as can IPU in soil on tractor wheels, but this is again insignificant compared with IPU washing from soil

Year two results clearly show that rainfall in the post-spraying period leads to a massive increase in IPU in the river which will inevitably lead to concentrations at public water abstraction point exceeding the EU maximum for drinking water of 0.1μg/l.

Advice to farmers from the VI on how to reduce herbicide pollution in the six Catchment Collaboration Projects includes the following:

VI measure	Comment
Text messaging farmers to spray if no rain forecast for 3 days	Insufficient time period to prevent IPU leaching to drains and often impractical due to weather and soil conditions
Use decision trees to plan herbicide application	Effectiveness depends on weather and willingness of farmer to delay weed control
Create buffer strips along water courses using set-aside	Effective if wide enough and spraying only occurs in low wind speeds.
Mop up spills on paved areas	Cherwell study revealed that small spills were not considered to be significant to spray operators and were not cleaned up.
Use the right amount of spray for the area	This would minimise the quantity of herbicide used but can be difficult in practice.
Choose filling area carefully to prevent run-off to drains and clean up all splashes	Common sense not to fill on paved surfaces next to drains but ignores pollution of groundwater

	from porous filling sites and the difficulties in cleaning up splashes. Little impact on pollution in wet years
Handle and clean waste packaging to prevent herbicide losses and dispose of legally.	Common sense but very marginal impact on total pollution loads. Burning packaging will soon be illegal under waste regulations.
Do not spray if soil is water-logged or frozen	Common sense but no evidence that these practices are common and add to pollution loads
Do not spray if heavy rain is falling or expected	Could occur on very well drained soils but in wet years time intervals between spraying and rainfall may be too short to prevent pollution
Avoid spray drift by sprayer adjustment and only spraying when wind speeds are Force 2 or below	May only be effective if LERAPs completed and buffer zones correctly observed.
Never pour waste into waterways or drains	Such practices are illegal but can happen.
Maintain sprayer to avoid leaks and drips	Legal requirement

To date the impact of the VI Catchment Collaboration Projects on water pollution has been mixed. In the Cherwell, pesticide pollution with IPU and chlortoluron continues despite intensive education and information efforts. In the Blythe and the Leam projects farmers were congratulated in 2003 because the levels of IPU "reduced significantly last season"[3]. However in the previous Newsletters for both catchments the VI reported[4]:

"The very wet 'back–end' to 2002 meant that much isoproturon (IPU) was not used and water monitoring results must be viewed in this light"

Thus farmers appear to be given a pat on the back for achieving a result that was entirely due to the weather and not any action they took.

The catchment programmes to reduce pesticide pollution are very intensive. It is highly unlikely that they would be affordable over the whole country to the same degree even if they produce positive results. It is clear from the VI reports that farmer recruitment has been slow.

The overwhelming conclusion from the Cherwell study is that IPU pollution is inevitable if spray operations are followed quickly by rainfall that causes field drains to run. In drier years IPU levels will be lower and point sources will contribute proportionally more to the total in the river. In wet years IPU from point sources will be insignificant compared with field runoff. The only certain way to obviate the need to treat water supplies to remove herbicides is to ban IPU.

References

1 ADAS , undated, River Cherwell Catchment Monitoring Study 1998-2000

2 The Voluntary Initiative Draft of booklet Every drop counts – keeping water clean

3 Voluntary Initiative, 2003, Blythe and Leam Catchment newsletter Autumn 2003

4 Voluntary Initiative, 2003, Blythe and Leam Catchment newsletter no 2 March 2003.